SECTION 400

SURFACE COURSES, PAVEMENTS AND SHOULDERS

SECTION 400. SURFACE COURSES, PAVEMENTS, REHABILITATION AND SHOULDERS

SECTION 403. BITUMINOUS SURFACE TREATMENT (CLASS A-1, A-2, A-3)

403.09 Application of Bituminous Material

Hand spraying of the bituminous material will be permitted in inaccessible areas such as narrow driveways, mail box turnouts and sidewalks. Hand spraying is more difficult to control than pressure spraying from the distributor and you will find a tendency to overrun the application amount of material. Precautions should be taken prior to starting the application of the bituminous material to see that the equipment is functioning properly and will give uniform distribution. Unless the roadway is closed to traffic, the bituminous material should be blotted immediately with prime coat aggregate. This will prevent pick up of the material by traffic and permit the curing of the prime coat. Excess aggregate in gutters and driveways should be removed prior to placing the surface course.

403.12 & 403.13 Cover and Seal Coats

It is very important for embedment of the aggregate into the bituminous material. The aggregate must be spread and rolled immediately following the bituminous application. The aggregate spreader should be checked to ensure it is operating properly.

SECTION 406. BITUMINOUS CONCRETE BINDER AND SURFACE COURSE CLASS I

406.04 General

Prior to the delivery of the mixture, the base shall be prepared or constructed to the correct grade, cross section and compacted to the density specified.

If the paving operation sequence is not set forth in the contract, the Contractor should discuss a proposed sequence of paving operations with the Engineer.

Prior to Paving. The Resident and Inspectors should be thoroughly familiar with the plans and Specifications for the project. Review first day start-up procedures, they may vary depending upon location and mix. Refer to Construction Memorandum No. 55, Placement of Bituminous Mixtures. In addition, they must have the equipment necessary to check all phases of the paving operations. They should check with the Superintendent on the paving sequence to see that the construction equipment on the project is of the number, size and condition required by the Specifications. Prior to paving operations, the Inspector should thoroughly check the surface on which the pavement is to be placed. If the surface is a base or subgrade, a prime coat, when required shall be applied and thoroughly cured. The surface should be checked for correct grade and cross section, and all work areas, depressions or potholes shall be repaired to give a firm and unyielding paving base. When an existing surface is to be resurfaced, the surface shall be cleaned of dirt and other extraneous matter and all base failures repaired. If a leveling course is to be applied, the existing surface should be checked and the roughest areas marked for level binder. A light fog coat of prime may be required on surfaces when there has been a long delay in the paving operations.

Inspection of Paving Equipment. The Inspector should make a personal inspection of the Contractor's paving equipment, checking the condition and adjustment of the component parts of the paving machine and rollers. By making this inspection prior to beginning paving operations, obvious deficiencies in the condition of the equipment may be discovered and

corrected, thus avoiding delays once the work is under way and to ascertain that the best possible surface can be obtained. Listed below are some of the more important details the Inspector should check during the inspection of the paving equipment.

Paving Equipment. Refer to Construction Memorandum No. 11, Bituminous Spreading and Finishing Machines Approved for Use in Illinois - Article 1102.03. The inspector should be familiar with the mechanical features on the type of paver to be used on the project

Spreading and Finishing. The bituminous mixture is spread and finished by a self-propelled paver. In irregular areas, the mixture may be spread and finished by hand.

The Inspector routine duties are to collect load tickets and control the location and length of spread of each load, however, their principal duty is to construct a pavement to the correct grade and cross section and with a surface texture and riding surface proposed in the contract. To achieve these results, the Inspector must continually check the base, the mixture, surface texture, rolling operation, and paved surface. The finished surface should be checked for crown and smoothness by using a carpenter's level and string line.

As the trucks arrive with the mixture, the Inspector should collect and initial each ticket and visually inspect each truck for leaking fluids which could contaminate the mat. The Inspector should check each truck load of mixture for uniformity and occasionally the temperature of the mixture.

An effective and timely means of communication between jobsite and plant personnel is essential to placing a workable and uniform mix on the road. The depth should be checked frequently to ensure the proper amount of mixture is being placed. Yield should be checked frequently to ensure there is not an excessive amount of overrun or under-run of plan quantity.

As the paver proceeds, the grade or thickness control device shall be adjusted to give the thickness required by the plans. Because continuity of paving operations is essential to securing a quality pavement surface, the optimum paver speed is controlled by the coordination of roller capabilities and plant production, within specification limits. By inspecting the surface texture behind the machine, and checking the surface with a straightedge, a malfunction in the paver operation or segregation of mixture may be detected.

406.05 Keeping Road Open to Traffic

Unless specified in the contract, one-way traffic shall be maintained during the priming and placing of the bituminous course. Traffic control to handle the one-way traffic is required by the Contract and shall be in place prior to moving the equipment on to the pavement to start operations.

Traffic control should be discussed at the pre-construction conference. Due to the relatively fast movement of paving operations, most of the traffic hazards are concentrated around the paving area. Traffic shall be directed through the construction area in accordance with the Contract traffic control in a manner that provides maximum safety for the workers and traveling public.

406.06 Preparation, Priming and Leveling of Brick, Concrete or Bituminous Bases

On two lane highways open to traffic only one lane shall be primed at a time, and the adjacent lane shall not be primed until prime on the first lane has cured or fine aggregate has been applied so that it will not pick up under traffic. De-bonding of the subsequent layer can result if

the prepared surface is not cleaned and kept clean. It is important that the correct amount of prime is applied.

406.14 Transportation

Trucks hauling the hot mix material shall be insulated and covered in accordance with the Specifications. The covering shall be rolled back prior to the truck starting to dump so the material can be inspected before it is actually placed. The material should be visually checked in the trucks to see if there is any sign of segregation.

406.15 Placing

In addition to the maximum paver speed specified in Article 406.15, paver speed is further constrained by the maximum roller speed to the extent that the vibratory roller is able to perform the required number of passes and still keep up with the paver. A pass of the roller is defined as one trip of the roller in one direction over any one spot.

Whenever a vibratory roller is in the paving train, the vibratory roller speed required to produce no less than 30 impacts/m (10 impacts per foot) controls the paver speed. The paver speed shall be mated with the required roller speed, not to exceed 15 m (50 ft) per minute. Maximum speed of the vibratory roller, in the static mode, should not exceed 5 km/h (3 mph) or 80 m/min. (264 feet/minute).

$$\text{Maximum Vibratory Roller Speed} = \frac{\text{Measured Frequency}}{10}$$

$$\text{Maximum Paver Speed} = \frac{\text{Measured Frequency}}{10 \times \text{No. Required Passes}} \times .9$$

Example: Measured frequency 2200 VPM @ 5 passes to cover the full mat width

$$\text{Max. Vibratory Roller Speed} = \frac{2200}{10} = 220'/\text{min.} = 2.5 \text{ mph}$$

$$\text{Max. Paver Speed} = \frac{2200}{10 \times 5} \times .9 = 39.6'/\text{min}$$

406.16 Compaction

Refer to Construction Memorandum No. 55, Placement of Bituminous Mixtures

Rollers of the type and number set forth in the Standard Specifications shall be used in compacting the mixture.

Effective use of vibratory rollers for compaction of bituminous concrete depends on the following major factors:

1. Lift Thickness
2. Roller and Paver Speeds
3. Total Applied Force (Sum of Static and Dynamic)
4. Frequency
5. Amplitude
6. Condition of Equipment

To obtain optimum results of density and smoothness requires an understanding of the interaction of the above factors. For example, an improper balance of amplitude and frequency can result in a marginal density and/or a rough surface.

The total applied force is the sum of the dynamic force and the static weight force. The formula for dynamic force is $\frac{wrf^2}{35235}$

w = weight of eccentric
r = radius of weight
f = velocity of frequency of eccentric

The amplitude is adjusted by changing the weight of the eccentric. Frequency is controlled by engine speed.

Frequency Control

The frequency vibration is controlled by engine speed not roller speed. Manufacturers show frequency as a function of engine rpm and it is normally shown on the rpm dial. A vibrating Reed Tachometer should be available from the Contractor or your supervisor so that you can measure the operating frequency of the roller.

Maximum Roller Speed

To determine the proper roller speed divide the measured frequency by 30 impacts/m (10 impacts/foot) (Article 406.16).

Thus a roller with 2400 vpm/30 impacts/m (10 impacts/foot) = 80 m/min (240 feet/minute) roller speed. If a roller was operated at 122 m/min (400 ft/min) with a 1600 frequency the spacing would be 75 mm (3 in) which would result in ripples and lower density because the dynamic energy into each square meter (square yard) would be reduced by two-thirds.

Paver Speed Conversion Factors

Inches x 25.40	=	Millimeters
Feet x 0.3048	=	Meters
Miles x 1.6093	=	Kilometers
Pounds x 0.4536	=	Kg
PLI x 0.1786	=	N/mm

SECTION 420. PORTLAND CEMENT CONCRETE PAVEMENT

The following information, as it applies, is also relative to Continuously Reinforced Concrete Pavement.

Prior to starting any concrete work, it is necessary that you review the contract documents.

420.05 Preparation of Subgrade or Subbase

The subgrade or subbase must be checked to ensure that it at the proper grade and cross section. The riding quality of the new pavement will depend largely on the smoothness of the grade on which it is placed.

420.17 Slipform Method

Preparation to Paving. The original paving stakes used for checking the earth grade and the placing and checking of the subbase material should not be disturbed prior to starting the slipform paving. This will prevent any error in reestablishing the pavement grades.

The subbase material must be checked for thickness, density, line and grade prior to placing the continuously reinforced pavement steel. Once the subbase material is approved and paving has started, it is important to continually check the thickness of the pavement behind the slipform paver, the condition and location of the reinforcing steel ahead and behind the slipform paver and the edge slump while the pavement is being placed.

Edge slump can be controlled by using a uniform mix with consistent slump and proper adjustment of the edge plates on the slipform paver. If excessive edge slump over that permitted by the Standard Specifications is evident, either wood planks or metal forms should be placed against the pavement immediately and the pavement brought to the proper grade. Metal forms usually work better than wood planks as they will lock together and will not cause variations in the pavement edge. As the paving progresses, a metal probe can be inserted in the pavement to determine the thickness. Refer to the *Project Procedures Guide* in this manual for types and frequencies of tests.

Review the contract documents in advance to determine the locations of key ways, tie bars, wide flange beams and super elevations. These locations must be adequately staked or marked. The wide flange beams at the pavement ends and structures are constructed in advance of the paving operations and the slipform paver then paves through the wide flange beams.

Do not permit the Contractor to use bricks or other similar material under the reinforcing steel. Sand plates are required for all bar supports.

Provisions should be made prior to starting formless paving to take care of any sudden rain that may occur. The Standard Specifications require sufficient polyethylene or burlap be on the job to cover such emergencies. You should discuss this issue with the Contractor prior to the start of paving operations.

Split header boards must be used on continuously reinforced pavement so that the reinforcing steel may be extended past the header board at the proper elevation. The pavement standards in the contract require additional reinforcing bars at each header. There is a minimum distance from the laps of the steel where a header may be placed. A portable vibrator must be used for

vibrating the concrete adjacent to header board at the end of the day's paving and also at the start of the following day's paving. The internal vibrators on the slipform paver will not cover this area. Failures on continuously reinforced pavement are usually the result of improper consolidation at the header boards or improper placement of the reinforcement. Excess mortar carried by the paver should not be placed in the pavement but should be wasted. All concrete protruding between the header boards should be chipped off flush with the pavement face prior to the next pour.

420.18 Tolerance in Thickness

Pavement shall be constructed to full plan thickness. For continuously reinforced pavement, the ratio of the steel area to the concrete area is a critical design factor for the pavement structure. It is neither desirable to have thin pavement nor thick pavement as the ratio of steel to concrete is correspondingly increased or decreased depending on the pavement thickness. Special care must be exercised in super elevation transition areas to avoid thin pavement.

SECTION 424. PORTLAND CEMENT CONCRETE SIDEWALK

Your plans should include details addressing the treatment of sidewalk accessibility ramps for disabled persons in order to comply with the Americans with Disabilities Act (ADA). Be sure you are familiar with these details, the related standards and inform the Contractor of the requirements as well.

The ADA requirements are law and must be implemented on roadway improvements. If a problem exists relating to implementing ADA requirements, contact your supervisor.

SECTION 442. PAVEMENT PATCHING (Concrete Patches)

442.05 Pavement Removal

You should review the contract documents for the requirements relating to patching prior to beginning patching operations. Prior to patching, mark out the required patch locations and contact your supervisor for a field review of the locations you have determined.

SECTION 483. PORTLAND CEMENT CONCRETE SHOULDERS

Prior to construction of PCC shoulders, the subgrade must be properly prepared. Tangents, superelevations and transitions must be calculated and constructed properly so the shoulder surface and thickness will conform to that shown on the plans.

STATE OF CALIFORNIA—BUSINESS, TRANSPORTATION AND HOUSING AGENCY

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OPERATION OF CALIFORNIA PROFILOGRAPH AND EVALUATION OF PROFILES

CAUTION: Prior to handling test materials, performing equipment setups, and/or conducting this method, testers are required to read "**SAFETY AND HEALTH**" in Part 4 of this method. It is the responsibility of the user of this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed.

A. SCOPE

The operation of the California profilograph, the procedure used for determining the Profile Index from profilograms of pavements made with the profilograph, and the procedure used to locate individual high points in excess of 7.5 mm are described in Parts 1, 2, and 3, respectively, in this test method.

PART 1. USE OF THE CALIFORNIA PROFILOGRAPH

A. EQUIPMENT

The California profilograph consists of a frame 7.62 m in length supported upon wheels at either end. The profile is recorded from the vertical movement of a wheel attached to the frame at mid-point and is in reference to the mean elevation of the points of contact with the road surface established by the support wheels (see Figure 1). The profilogram is recorded on a scale of 1 mm equal to 300 mm longitudinally, and 1 mm equal to 1 mm, or full scale, vertically. Motive power may be provided manually or by the use of a propulsion unit powered with a gasoline engine attached to the center assembly.

B. OPERATION AND CALIBRATION OF THE PROFILOGRAPH

The instructions for assembling the profilograph are contained in a booklet accompanying each unit.

In operation, the profilograph should be moved at a speed no greater than a walk so as to eliminate as much bounce as possible. Too high a speed will result in a profilogram that is difficult to evaluate.

Calibration of the profilograph should be checked periodically. The horizontal scale can be checked by running a known distance and scaling the result on the profilogram. If the scale is off, the profile wheel should be changed to one of a proper diameter. The vertical scale is checked by putting a board of known thickness under the profile wheel, and again, scaling the result on the profilogram. If the scale is off, the cause of the incorrect height should be determined and corrected.

NOTE: Read the "Precautions" section in the instruction booklet prior to using the California profilograph.

PART 2. DETERMINATION OF THE PROFILE INDEX

A. EQUIPMENT

To determine the Profile Index, use a plastic scale 40 mm wide and 333.3 mm long representing a pavement length of 100 m or 0.1 km at a scale of 1:300. A plastic scale for the profilograph may be obtained by the districts from the Transportation Laboratory. Near the center of the scale is an opaque band 5 mm wide extending the entire length. On either side of this band are scribed lines 2 mm apart and parallel to the opaque band. These lines are used to measure deviations or

excursions of the graph above or below the blanking band. The deviations are called "scallops".

B. METHOD OF COUNTING

Place the plastic scale over the profile in such a way as to "blank out" as much of the profile as possible. When this is done, scallops above and below the blanking band usually will be approximately balanced. See Figure 2.

The profile trace will move from a generally horizontal position when going around super elevated curves making it impossible to blank out the central portion of the trace without shifting the scale. When such conditions occur, the profile should be broken into short sections and the blanking band repositioned on each section while counting, as shown in the upper part of Figure 3.

Starting at the right end of the scale, measure and total the height of all the scallops appearing both above and below the blanking band, measuring each scallop to the nearest 1 mm. Write this total on the profile sheet near the left end of the scale together with a small mark to align the scale when moving to the next section. Short portions of the profile line may be visible outside the blanking band, but unless they project 0.6 mm or more and extend longitudinally for 0.6 m (2 mm on the profilogram) or more, they are not included in the count. See Figure 3 for illustration of these special conditions.

When scallops occurring in the first 0.1 km are totaled, slide the scale to the left, aligning the right end of the scale with the small mark previously made, and proceed with the counting in the same manner. The last section counted may or may not be an even 0.1 km. If not, its length should be scaled and the counts proportioned to an equivalent 0.1 km section. For example, 9 counts in 0.07 km = 12.9 or 13 per 0.1 km.

The Profile Index is defined as "millimeters per 0.1 km in excess of the 5 mm blanking band," but is simply called the Profile Index.

C. LIMITATIONS OF COUNT IN 0.1 KM SECTIONS

When the specifications limit the amount of roughness in "any 0.1 km section", the scale is moved along the profile and counts made at various locations to find those sections if any, that do not conform to specifications. The limits are then noted on the profile and can be later located on the pavement preparatory to grinding.

D. LIMITS OF COUNTS — JOINTS

When counting profiles, a day's paving is considered to include the last portion of the previous day's work, which includes the daily joint. The last 5 to 10 m of a day's paving cannot usually be obtained until the following day. In general, the paving contractor is responsible for the smoothness of joints if he places the concrete pavement on both sides of the joint. On the other hand, the contractor is responsible only for the pavement placed by him if the work abuts a bridge or a pavement placed under another contract. Profilograph readings, when approaching such joints, should be taken in conformance with current specifications.

PART 3. DETERMINATION OF HIGH POINTS IN EXCESS OF 7.5 MM

A. EQUIPMENT

Use a plastic template having a line 25 mm long scribed on one face with a small hole or scribed mark at either end, and a slot 7.5 mm from and parallel to the scribed line. See Figure 3. (The 25 mm line corresponds to a horizontal distance of 7.5 m on the pavement.) The plastic template may be obtained from Transportation Laboratory.

B. LOCATING HIGH POINTS IN EXCESS OF 7.5 MM

At each prominent peak or high point on the profile trace, place the template so that the small holes or scribe marks at each end of the scribed line intersect the profile trace to form a chord across the base of the peak or indicated bump. The line on the template need not be horizontal. With a sharp pencil draw a line using the narrow slot in the template as a guide. Any portion of the trace extending above this line will indicate the approximate length and height of the deviation in excess of 7.5 mm.

There may be instances where the distance between easily recognizable low points is less than 25 mm (corresponding to 7.5 m on the pavement). In such cases a shorter chord length shall be used in aligning the scribed line on the template tangent to the trace at the low points. It is the intent of this requirement that the baseline for measuring the height of bumps will be as near to 25 mm as possible, but in no case exceed this value. When the distance between prominent low

points is greater than 25 mm (corresponding to 7.5 m on the pavement), make the ends of the scribed line intersect the profile trace when the template is in a nearly horizontal position. Examples of the possible positions are shown in Figure 3.

PART 4. SAFETY AND HEALTH

Use leather gloves when assembling and storing the profilograph frame. Use proper lifting methods and be aware of pinch points and sharp edges.

Prior to handling gasoline, or operating equipment, operators are required to read Caltrans Laboratory Safety Manual Part A, Section 5.0, Hazards and Employee Exposure; Part B, Section 5.0, Safe Laboratory Practices; and Part C, Section 1.0, Safe Laboratory Practices and Section 2.0, Field Operations and Testing. Users of this method do so at their own risk.

End of Text (California Test 526 contains 6 Pages)

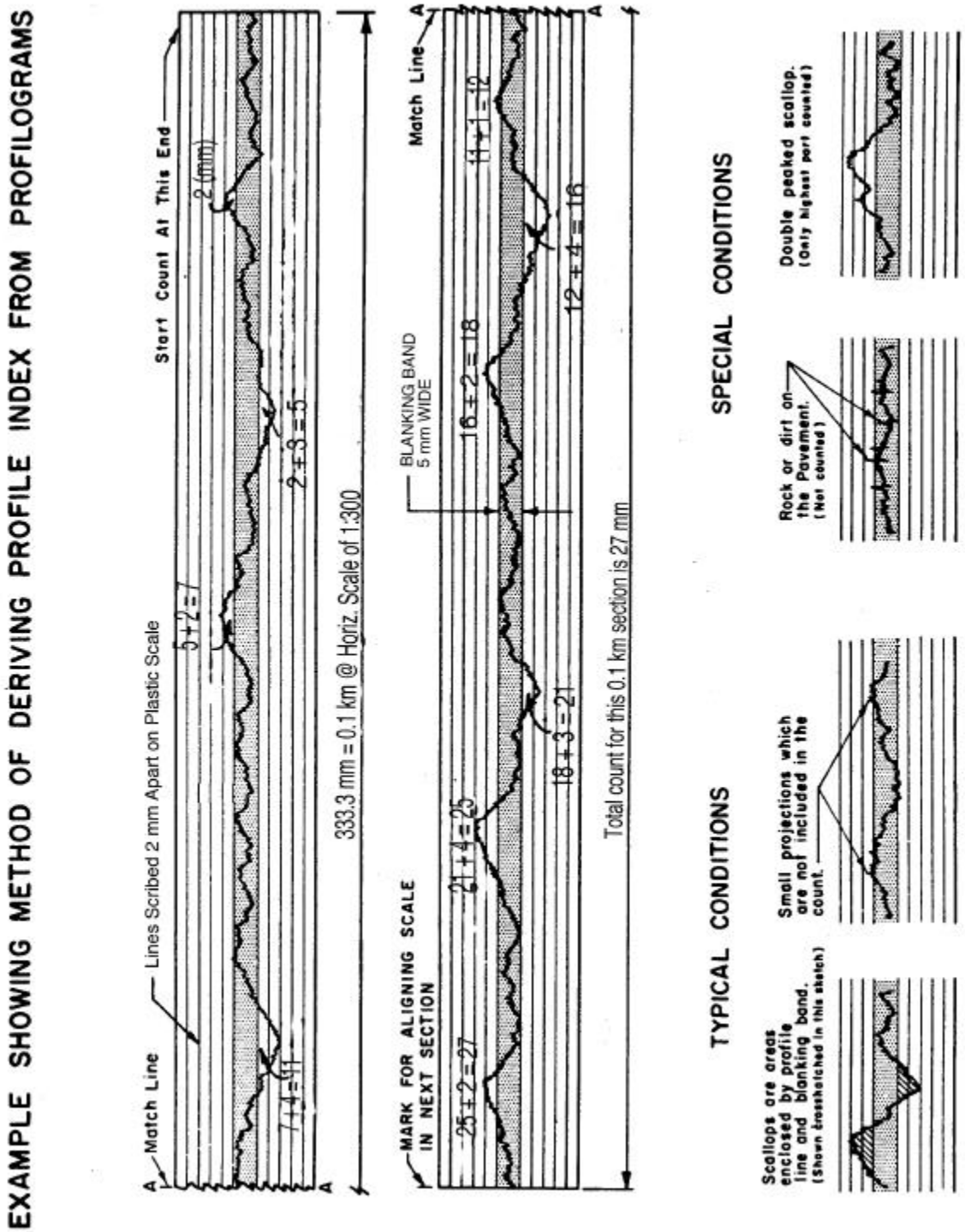
EXAMPLE SHOWING METHOD OF DERIVING PROFILE INDEX FROM PROFILOGRAMS
Match Line
Lines Scribed 2 mm Apart on Plastic Scale
Start Count At This End
2 (mm)
5+2=7
2+3=5
7+4=11
333.3 mm = 0.1 km @ Horiz. Scale of 1:300
MARK FOR ALIGNING SCALE IN NEXT SECTION
BLANKING BAND 5 mm WIDE
Match Line
25+2=27
21+4=25
18+3=21
16+2=18
11+1=12
12+4=16
Total count for this 0.1 km section is 27 mm
TYPICAL CONDITIONS
SPECIAL CONDITIONS
Scallops are areas enclosed by profile line and blanking band. (Shown crosshatched in this sketch)
Small projections which are not included in the count.
Rock or dirt on the Pavement. (Not counted)
Double peaked scallop. (Only highest part counted)
A
B
C
D

FIGURE 1

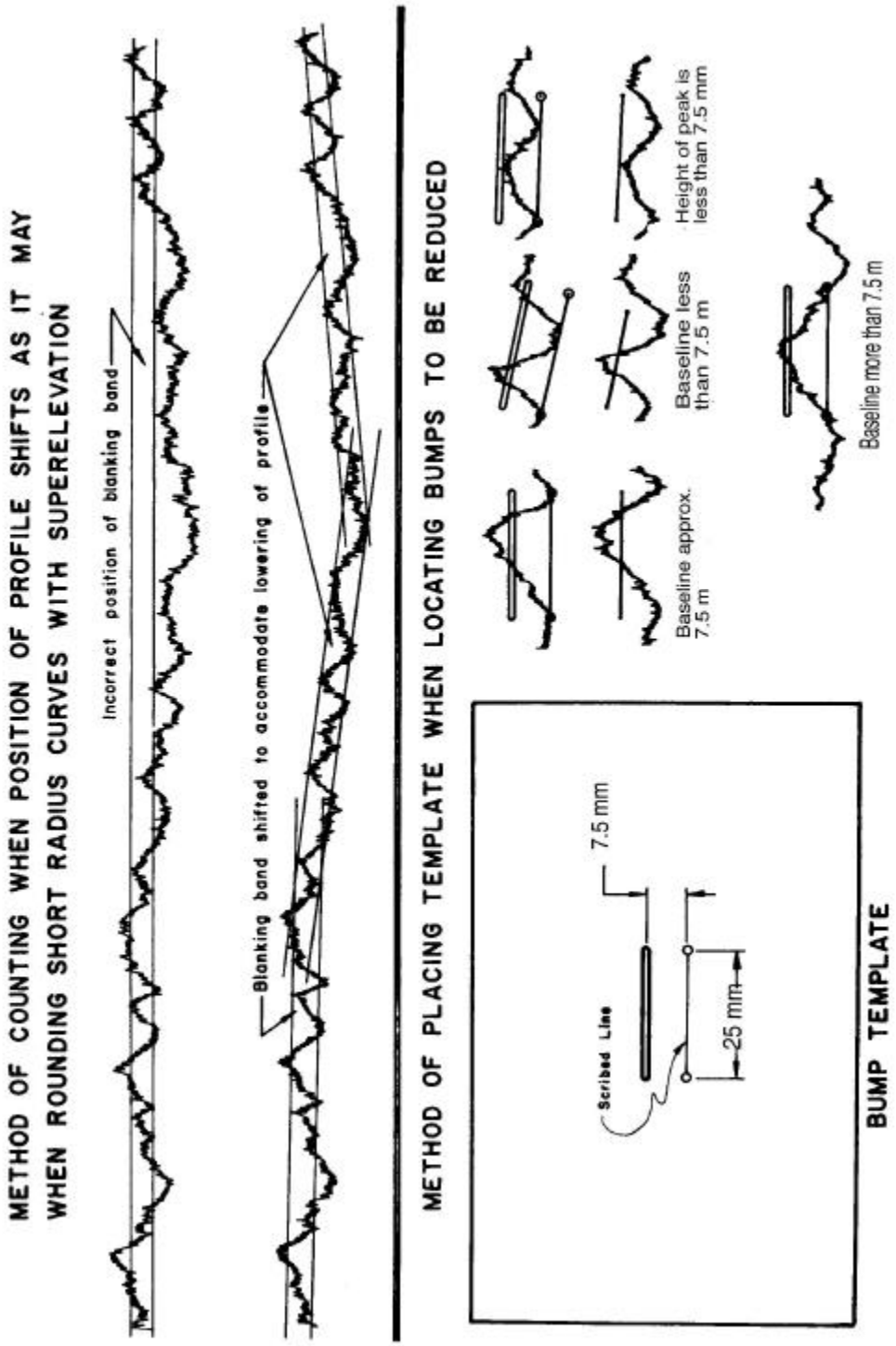
METHOD OF COUNTING WHEN POSITION OF PROFILE SHIFTS AS IT MAY WHEN ROUNDING SHORT RADIUS CURVES WITH SUPERELEVATION
Incorrect position of blanking band
Blanking band shifted to accommodate lowering of profile
METHOD OF PLACING TEMPLATE WHEN LOCATING BUMPS TO BE REDUCED
Baseline approx. 7.5 m
Baseline less than 7.5 m
Height of peak is less than 7.5 mm
Baseline more than 7.5 m
Scribed Line
7.5 mm
25 mm
BUMP TEMPLATE

FIGURE 2

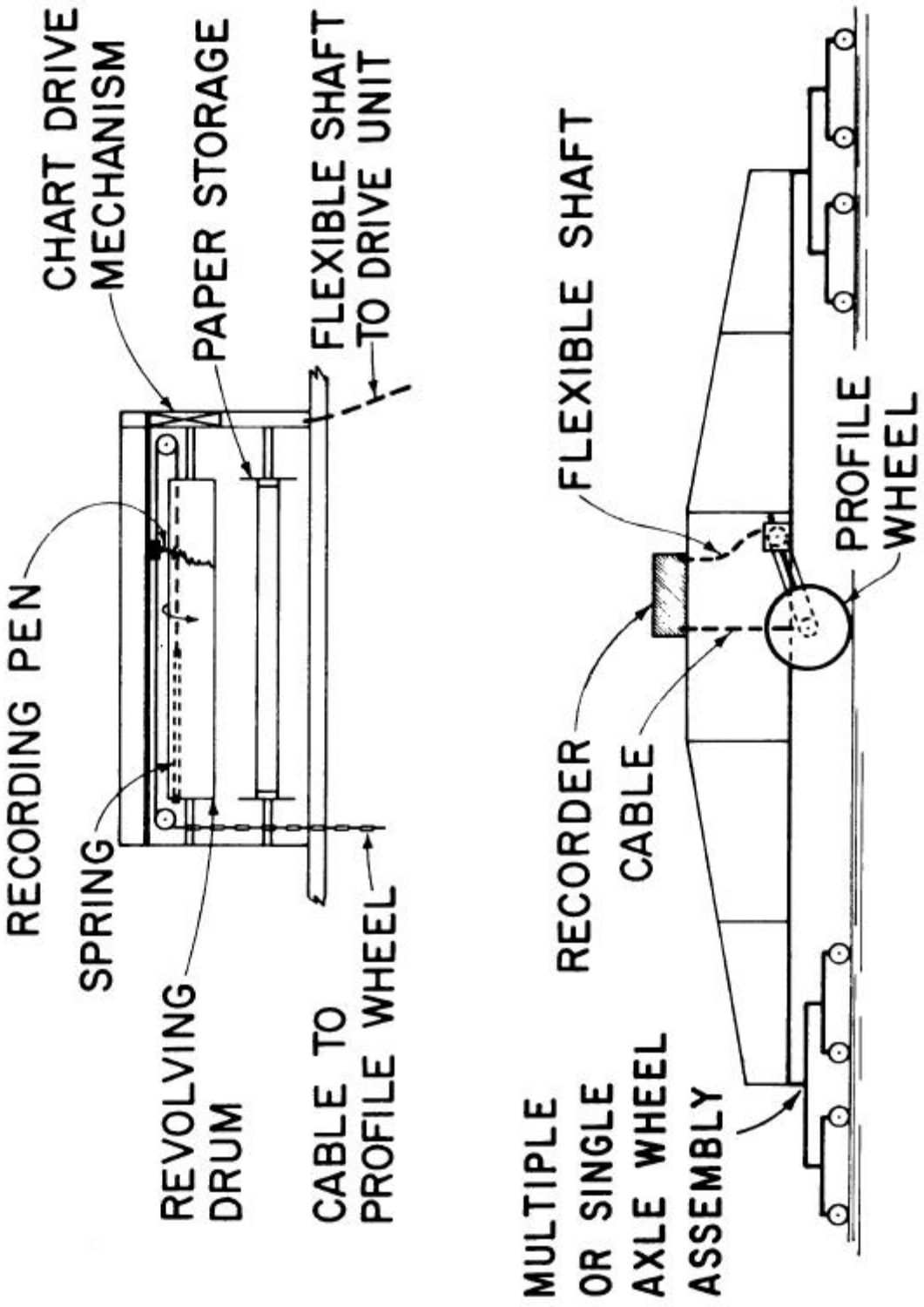
CHART DRIVE MECHANISM
PAPER STORAGE
FLEXIBLE SHAFT TO DRIVE UNIT
RECORDING PEN
SPRING
REVOLVING DRUM
CABLE TO PROFILE WHEEL
FLEXIBLE SHAFT
RECORDER CABLE
PROFILE WHEEL
MULTIPLE OR SINGLE AXLE WHEEL ASSEMBLY

FIGURE 3